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ABSTRACT

The purpose of this publication is to assist educators in their efforts to improve students' thinking abilities. The book identifies and describes some common components of thinking skills programs and addresses the scope and sequence of purposeful thinking. In some respects, the content of thinking is described by offering a generic organization of thinking skill components and terms which are common to many thinking skills programs. A possible list of thinking processes/skills and dispositions is provided as a starting point. Armed with some common terms and a beginning list, classroom teachers or district task force members may begin to construct a plan of action to improve student thinking. The thinking skills component and the partial list of process/skills and dispositions are intended to offer a possible point of view and a starting place. In this way, educators may begin with a common vocabulary and an overall framework to adopt, design, and evaluate both commercial and district-developed thinking skill programs. Through these actions, a consistent thinking skills curriculum may be developed and become an integral part of students' school experience. (RH)

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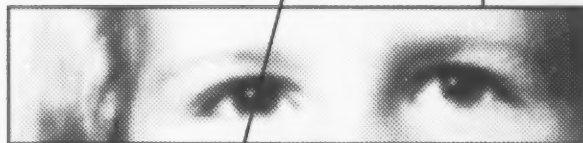
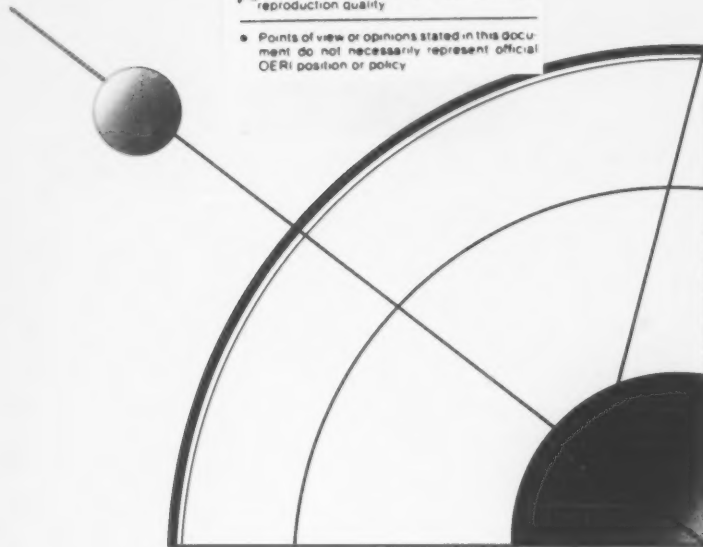
OPTIMIZING STUDENT LEARNING: a guide to purposeful thinking

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OPTIMIZING STUDENT LEARNING: **a guide to purposeful thinking**

Sarah J. Smith, Specialist, Instructional Design/Gifted Education
Diane G. Heecox, Teacher on Special Assignment
Instructional Design Section
Minnesota Department of Education

Tom Nelson, Commissioner Of Education
Mae Gaskins, Ed. D., Assistant Commissioner
Dr. Gilbert Valdez, Manager, Instructional Design

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TABLE OF CONTENTS

Preface	v
OVERVIEW: The Thinking Skills Movement	3
Goals	3
Ways to "Teach" Thinking	3
Direct Instruction and Content Integration	3
ELEMENTS: Thinking Elements - What's Your Cognitive Style?	9
Dispositions	9
Metacognition	13
Processes	14
Summary	15
FRAMEWORK: A "Generic" Scope and Sequence	19
Planning for Thinking	19
Organization of the Framework	23
Elementary (K-3)	29
Conceptualize	29
Produce	35
Evaluate	43
Middle School (4-8)	49
Conceptualize	49
Produce	53
Evaluate	65
Senior High (9-12)	71
Produce	71
Evaluate	77
EVALUATION: Assessment and Evaluation of Student Thinking	83
Dispositions and Metacognition	84
Thinking Processes/Skills	84
Complex Tasks	85
Products	85
Summary	86
REFERENCES	89
Suggested Readings	89

Preface

"To think, it seems to me, is to hold an idea long enough to unlock and shape its power in the varied contexts of shared human knowledge."

(John-Steiner 1985)

The purpose of this publication is to assist educators in their efforts to improve students' thinking abilities. *Optimizing Student Learning: A Guide to Purposeful Thinking* provides assistance by identifying and describing some common components of thinking skills programs and offers an example of a scope and sequence for purposeful thinking. In some respects, the "content" of thinking is described by offering a "generic" organization of thinking skill components and terms which are common to many thinking skills programs.

A possible list of thinking processes/skills and dispositions is provided as a starting point. Armed with some common terms and a beginning list, classroom teachers or district task force members may begin to construct a plan of action to improve student thinking. The thinking skills components and the partial list of process/skills and dispositions are intended to offer a possible point of view and a starting place - it is not *the* list or the State Department's program. In this way, educators may begin with a common vocabulary and an overall framework to adopt, design, and evaluate both commercial and district-developed thinking skill programs. Through these actions a consistent "thinking skills curriculum" may be developed and become an integral part of students' school experience.

The efforts of Mary Jelinek, Resource Teacher of the Gifted, Rosemount/Apple Valley Schools, and Jackie Saunders, Educational Consultant, Wyoming, Minnesota, in the initial development and refinement of the critical list of processes are greatly appreciated. Karen Rogers, Head, Gifted Studies Program, College of St. Thomas, St. Paul, Minnesota, provided the suggested evaluation criteria for each of the processes and skills. Her contributions to the emerging field of assessment and evaluation of thinking skills are extremely valuable.

Sarah J. Smith, Specialist, Instructional Design/Gifted Education
Diane G. Heacox, Teacher on Special Assignment
Instructional Design Section

Goals: One goal of a thinking skills program is to increase the students' repertoire of processes/skills, enabling them to have a set of tools for thinking and an awareness of the appropriate selection of these tools to accomplish complex tasks. Additionally, as students become more accomplished, their confidence and willingness to engage in demanding work is increased and a positive disposition toward challenging tasks is enhanced. It is generally agreed that the explosion of information available to us in the future requires a greater emphasis on analysis, synthesis, and evaluation processes.

Ways to "teach" thinking:

The premise of thinking skills programs is that all students can become more accomplished thinkers with instruction. Thinking skills instruction involves the planning of instructional events which engage the learner in challenging tasks. A guiding principle in the development of higher order thinking skills is that students become active thinkers - participants in the learning process, rather than passive receivers of information.

Several factors are considered when the classroom teacher works with students in a deliberative fashion to guide student thinking. Methods of instruction or modifications in the classroom environment may include: instruction using a directive or inquiry approach, the design of challenging student tasks, use of effective questioning strategies, and the development of a positive classroom climate. A brief description of each of these follows.

Direct instruction and content integration:

The teacher guides and coaches thinking through direct instruction and interaction with students. Direct instruction follows a basic outline. The process/skill is defined, practiced, reviewed, and reinforced. Initial instruction may be delivered through the use of explicit lessons which are "directly" taught and which focus on the process/skill or behavior. The content is generally fairly easy and familiar to the student so that the attention of the learner is focused on the process or skill, rather than the acquisition of new content.

An assumption about the teaching of thinking skills is that whatever method(s) of instruction is selected by the teacher, thinking processes/skills are practiced and integrated into a content area. Explicit (directive) lessons are closely followed by a content area application and a link of the process/skill to daily living.

Lesson design. The design of student tasks which intrigue and challenge students' thinking is a strong component of thinking skills instruction. The teacher insists on the use of higher order thinking by constructing activities which engage the learner in productive or evaluative thinking. Often students will describe questions as "think" questions, as if other types of responses do not require thinking! For example, when students specialize in a topic for research and are asked to analyze or produce original work, the highest forms of thinking are in use.

Lesson remodeling occurs when student activities are examined and the level of thinking required is evaluated. The teacher then eliminates some activities and constructs new tasks which require higher order thinking. Thus, the activities are linked to the instructional content. These new activities extend student thinking by substituting the role of consumer of information for the role of producer of information. These lessons provide opportunities for independent thinking and purposeful use of appropriate strategies.

Questioning strategies. A rich area for investigation is the research conducted on "teacher talk." John Goodlad conducted a study of more than 1,000 classrooms and reported that over 70 percent of the time available for instruction in the classroom involved verbal interaction. "Observers noted that less than one percent of this "teacher talk" invited students to engage in anything more than a mere recall of information." (McTighe and Schollenberger 1985)

The careful construction of important questions and the behaviors exhibited by the teacher have a powerful impact on the development of students' thinking capabilities. Providing time for students to think and slowing down the fast-paced dialogue between teacher and students encourages reflection. This "wait" behavior is a valuable tool for encouraging more reasoned responses. Both open-ended questions and teacher behaviors are considered when promoting higher order thinking abilities among students using questioning strategies.

Climate. Another factor to be considered in the development of students' thinking is the climate of the classroom. What types of activities are encouraged? Are students provided with choices which promote independence in thought and action? Does the teacher model the use of processes/skills and behaviors which promote higher order thinking? Frequently, thinking programs which focus on climate emphasize the students' affect or disposition toward thinking tasks. Behaviors such as persistence or flexibility are encouraged. Descriptions of these behaviors are provided and students are encouraged to acquire these behaviors.

Selma Wasserman describes certain types of students who show "thinking impaired" behaviors. These behaviors may include students who are overdependent and who must ask for help every step of the way when working on a difficult assignment. (Wasserman 1987) By contrast, a student may be underconfident and show fear in expressing his or her viewpoint. A sign of a confident thinker is one who develops an original viewpoint, offers supporting evidence and shows confidence about his or her ability to formulate and share new ideas.

Thinking classrooms also emphasize "learning to learn" strategies. This may involve the use of memory techniques, study skills, time management, or organizational techniques. The message that is delivered by the arrangement of the environment and the encouragement of "thinking" behaviors is that independent thinking is valued and students can become more effective thinkers.

In Chapter Two, a broad framework of thinking components is introduced and a definition of processes, skills, and dispositions is offered, aimed toward a description of the "content" of thinking.

Cognitive style is defined by David Perkins as "...a recurrent pattern in the way a person approaches problems and more generally processes information." (Perkins 1981) Cognitive style is made up of three components which, when considered as a whole, are active when an individual accomplishes a challenging task. These three components are: disposition, metacognition, and the selection and use of processes/skills.

Dispositions:

Disposition may be defined as the individual's affect toward accomplishing certain types of tasks. It is made up of the individual's previous experience, preferences for certain types of work, a preferred style, and the individual's self-esteem as it relates to the task. An example of a disposition is the individual's willingness to persist when faced with a problem which is not easily solved.

Disposition also involves the individual's preferred style. Certain types of projects may be preferred by students. Some enjoy the challenge of breaking apart an argument and examining each part, while others are intrigued when asked to create a new theory. Although a student may be accomplished at many types of tasks, preferences do have an impact on disposition. Disposition is influenced by the things we like to do.

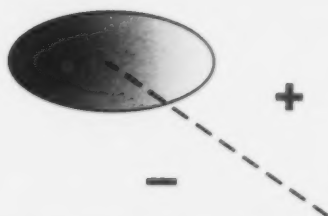
According to Beyer, dispositions may be "taught" using one or more of the following strategies: 1) modeling the desired dispositions, 2)insisting on student behaviors that reflect the dispositions sought, 3) planning activities which require the use of the disposition, and 4) reinforcing behaviors that demonstrate appropriate dispositions. (Beyer 1987)

In a sense, a disposition is a measure of one's confidence, openness, willingness, and flexibility. It has roots in our previous experiences. It is a measure of our previous success with challenging tasks and our ability to respond positively to new challenges. Dispositions involve the affective component of learning and have a dramatic impact on students' willingness to engage in complex learning.

ELEMENTS OF THINKING



DISPOSITIONS



PROCESSES



METACOGNITION

Metacognition:

Metacognition is a "consciousness of one's own thinking." (Costa and Presselien 1985) This is described as thinking about thinking, self-monitoring, or reflective thinking. Metacognition both precedes problem solving and is also present while one is engaged in the active phases of the process. In addition, metacognition occurs when the problem-solving results are reviewed. The individual actually "stands" outside of her or himself and is an observer, coach, and evaluator. It is also the ability to "playback" one's thinking after a problem has been solved.

Metacognition involves use of self-management strategies. Self-management strategies include knowing when to use a particular strategy and how to use this strategy in new problems. Some students intuitively know how to proceed in a thinking task, while others approach the task in a random and less effective manner. (Sternberg 1985)

An example of metacognition is when we are thinking about the effectiveness of a particular strategy while we are using it. For example, "How well defined is this problem?" Another example is when we speak to an audience and notice that the front row has fallen asleep. "I had better do something to wake them up! Perhaps I should become more dramatic." One is aware of his or her performance as an observer while engaged in action.

Metacognitive skills are acquired as the developmental abilities of the child for abstract thinking emerge and when the student is instructed about these thinking processes. (Beyer 1987) According to Barry Beyer, students develop their metacognitive abilities through "readiness" skills as they make choices, develop plans, reflect on how an answer was derived, and paraphrase what is heard. (Beyer 1987)

Direct instruction lessons take advantage of metacognition by asking the students to share their thinking after a brief exercise. It is believed that one way students may improve their thinking is to listen to other students who are successful thinkers as they describe their thinking processes. This awareness of one's thinking can be captured and described during the process or immediately after a task is completed. The individual's description of metacognition is a map of his or her thinking as it is traced from problem finding to problem solution.

Processes: Processes are broad and inclusive operations which are used to accomplish complex tasks. The term process implies a large operation which is made up of several phases or actions. Thinking processes are made up of: 1) strategies, 2) skills, and 3) heuristics.

Strategies. Strategies or schema are cognitive plans or mental maps used in accomplishing a task. When confronted with a new problem, the individual detects the familiar aspects of the problem and proceeds in a particular manner which has worked previously. In this way, a pattern is recalled and applied to a new situation. Strategies are potential plans or procedures which are selected because they may be useful to problem solution and they have worked previously with other, similar types of tasks.

David Perkins describes strategies or schemata as "...mental structures that allow a person to perceive or act effectively by anticipating the organization. The individual does not have to work from scratch because a pattern is recognized and therefore a potential procedure is revealed." (Perkins 1981)

Heuristics. Heuristics are defined as "... general strategies or rules of thumb used to solve problems and make decisions." (Costa and Presseisen 1985) A rule of thumb is a small cue to procedures or actions. For example, a rule of thumb in ideation (brainstorming), is that the object of ideation is to push for a large number of ideas and resist premature closure. A second rule of thumb in ideation is to combine ideas in unusual ways.

A heuristic does not represent the entire process, but may be thought of as a small clue as to what might work. For example, begin brainstorming with easy exercises and then tackle more demanding tasks after a warm-up exercise. Perkins compares heuristics to algorithms. While algorithms are an exact procedure that guarantees solutions, heuristics are "hit or miss" procedures which may work. (Perkins 1981)

Skills. Skills come together to make processes. Skills are abilities that come from knowledge, practice, or aptitude. A thinking skill in this context is an action which is applied and may assist the thinker to conceptualize, evaluate, or produce ideas. These "tools" for thinking produce convergent (one) or divergent (many) responses.

For example, ideation is a **process** to produce divergent responses. Students are asked to generate a quick list of ideas and to push for original ideas. **Skills** used in the ideation process include: fluency, flexibility, and originality.

When an individual is involved in complex tasks, skills are useful in solving or accomplishing certain aspects of a problem. The successful thinker selects appropriate skills and applies them in a competent manner. Skills are often the backbone of a program that promotes thinking since students may be unaware of the many tools available to assist them in their problem solving endeavors.

Programs promoting thinking introduce new skills and then practice them with different types of problems. The student thinker develops an awareness of skills, combines skills into thinking processes, evaluates their potential use, and efficiently recognizes opportunities to apply the skills in their problem- solving.

Summary: **An individual's cognitive style is his or her general pattern of thinking. It is made up of dispositions, metacognition, and processes.** Most thinking skills programs contain certain elements of all three of these components which make up an individual's thinking behavior.

Planning for thinking:

An examination of a thinking skills scope and sequence provides an illustration of the possible processes/skills or dispositions which may be beneficial to students at a particular grade level(s) or content area. The teacher searches for a "good fit" by deciding which of the processes/skills or dispositions are developmentally appropriate and naturally integrate into a content area. Once selected, a deliberate plan is devised to provide for the introduction, reinforcement, and extension of these skills.

A district- or building-level team may examine several thinking taxonomies and "assign" a thinking process/skill to a grade or content area. In this way, a plan for integration of these processes/skills is charted. The result is the orderly development of a district program or a classroom teacher's plan for a grade/content area.

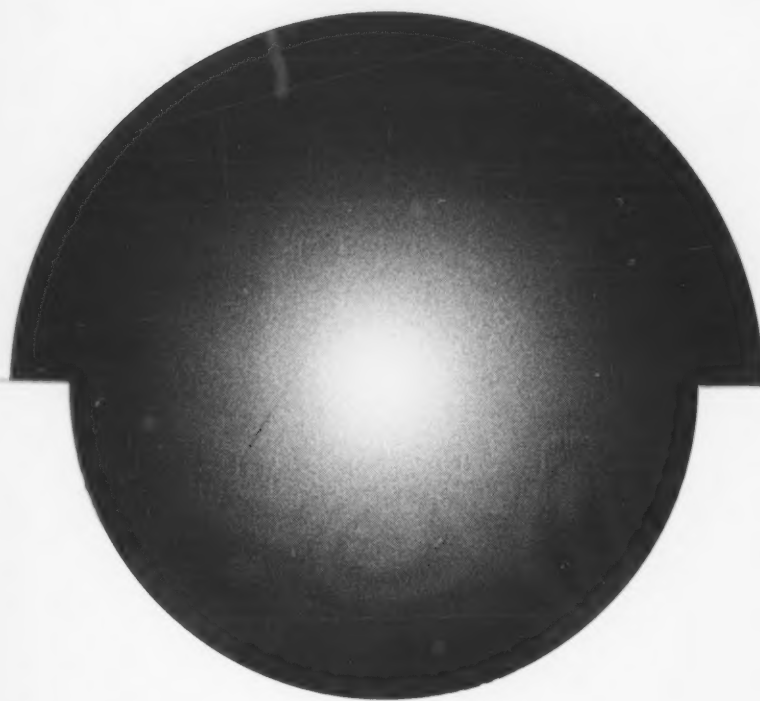
One method of examining commercial thinking programs is to detect the area of emphasis and then determine which components of thinking are being supported. Because the components of thinking influence the student's thinking capability, classroom teachers and district planners may wish to decide on an appropriate balance between processes/skills and dispositions.

For example, a classroom teacher may decide that at the tenth-grade level, students need more experience in analyzing the relevance of data (process) and some work on task persistence (dispositions). In contrast, teachers of primary age children may wish to focus on risk taking, flexibility, curiosity (dispositions), and ideation techniques (process).

The ability of students to use and enhance their metacognitive abilities is a matter of instruction and practice and is not described in the scope and sequence. However, students may be trained to pay attention to their "self-talk" and engage in pre-planning activities to select and apply processes.

PURPOSEFUL THINKING FRAMEWORK

PROBLEM SOLVING



Students also acquire and develop their metacognitive skills when the teacher models metacognitive thinking and describes the processes which are involved. Later, the students can be directed to use and share their "thinking about thinking" processes during an active phase of critical and creative thinking. Although it is possible to develop a sequence of activities related to the development of metacognition, it is not provided in this guide. An examination of the work of Barry Beyer in *Practical Strategies for the Teaching of Thinking* (1987) is suggested.

The "generic" scope and sequence for thinking which is offered in the ensuing pages is useful in that it provides a beginning list of dispositions and processes/skills. There are several premises which should be considered prior to the examination of this scope and sequence. They are described below.

**Organization of the
framework:**

The scope and sequence is designed to identify the purposes of thinking and relates these purposes to three broad operations: conceptualization, production, and evaluation. Conceptualization, evaluation, and production are integral components of problem solving. Dispositions for evaluation and production provide the affective basis for problem solving.

Dispositions. Dispositions precede the list of evaluative and productive processes. The dispositions suggest a general orientation to productive and evaluative thinking which increases the confidence and sophistication of students as they become more capable thinkers.

Processes by purpose. Processes are organized into three major purposes or operations which direct thinking. These purposes are to conceptualize, produce, and evaluate.

Conceptualization is the acquisition of knowledge and the mental representation of that knowledge by the individual. At its most sophisticated level, it is connecting, redefining, and creating new concepts-enlarging and refining one's mental organization.

Conceptualization is defined as the process of "... generalizing from specifics to invent concepts or models." (Beyer 1987) Conceptualizing enhances the acquisition, evaluation, or invention of concepts. The students learn to manipulate and reshape concepts and "...build a generalized mental image of that phenomenon." (Beyer 1987)

Production refers to the generation of original ideas. Production uses divergent thinking processes to engage the individual in creative actions. The end result of production is innovation.

Evaluation is the examination, analysis, and judgment of ideas. Evaluation uses critical thinking processes to scrutinize ideas such as: arguments, propositions, viewpoints, theories, or actions.

According to Ennis, "critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do." (Costa 1985) The end result of evaluation is a decision.

Summary of purposeful thinking framework. The most advanced level of thinking is problem solving in the broadest sense. Conceptualization, evaluation, and production interact simultaneously in decision making, innovation, and problem solving. Since thinking occurs within a given context, conceptualization and the development of a knowledge base is needed to engage in any thinking operation. Innovations and decisions are the result of conceptualization, evaluation, and production.

These operations are artificially separated only for purposes of examination. Because these are markedly different processes, the development of the scope and sequence and the organization of the dispositions does differ. A "forced fit" of processes and dispositions into a parallel format would be artificial and would not represent the differences in thinking operations.

The scope and sequence is not intended to be a complete or exhaustive list, just a fair representation of the field and a starting point. It is assumed that educators may use this list as a possible building block toward the development of an integrated thinking skills program.

Conceptualization is the acquisition of knowledge and the mental representation of that knowledge by the individual. At its most sophisticated level, it is connecting, redefining, and creating new concepts - enlarging and refining one's mental organization.

Process Understanding and Generalizing Concepts
Forms a generalized mental image (Beyer 1987)

Process Transforming Concepts
Revises, refines, and redefines concepts; builds new conceptual schemes.

Process Understanding and Generalizing Concepts

Key E= Elementary M= Middle School S= Senior High	Skill	(E) Defining
	Skill	(E) Paraphrasing
	Skill	(E) Describing
	Skill	(E) Attribute Listing
	Skill	(E) Patterning
	Skill	(E) Sequencing
	Skill	(E) Understanding Spatial Relationships
	Skill	(E) Classify
	Skill	(E) Compare and Contrast
	Skill	(E) Categorizing
	Skill	(E) Summarizing
	Skill	(M) Ordering Priorities
	Skill	(M) Explaining Ideas Clearly
	Skill	(M) Formulating

Transforming Concepts

Skill	(E) Understanding and Inferring Relationships
Skill	(M) Using Analogies
Skill	(M) Using Metaphors
Skill	(M) Designing Experiments
Skill	(M) Analyzing Trends
Skill	(M) Synthesizing Information

Produce

Production refers to the generation of original ideas. Production uses divergent thinking processes to engage the individual in creative actions. The end result of production is an innovation.

Process

Ideation

Produces ideas in a fluent and flexible manner

Process

Visualization

Develops mental pictures or images to discover new ideas, interpret symbols and concepts, find solutions to problems and challenges (Eberle 1982)

Process

Invention

Searches and selects ideas, devises and revises plans that improve or innovate (Perkins 1981)

Process

Synectics

Compares objects or ideas

Process

Planning

Perceives or acts effectively by anticipating the organization, involves both perception and production (Perkins 1981)

Process

Evaluation

Judges an idea to see whether it will work, looks at criteria, advantages and disadvantages (De Bono 1970)

Process

Problem Finding

Narrows a problem situation, proceeds to identification of an underlying problem. (Perkins 1981)

Process

Creative Problem Solving Model

Uses fact finding, problem identification, solution finding in the development of an action plan

•Productive processes are introduced and applied at increasing levels of sophistication by students. The definition and application of productive processes and skills changes as students mature. These processes are introduced in the K-3 curriculum and reinforced/extended as students advance in grade level.

Evaluate

Evaluation is the examination, analysis and judgement of ideas. Evaluation uses critical thinking processes to scrutinize ideas such as: arguments, propositions, viewpoints, theories, or actions. The end result of evaluation is a decision.

Process Recognizing Premises/Structure of Argument

Identifies central premise and detects a line of reasoning

Process Recognizing Viewpoint

Infers, recognizes, and appreciates the impact of viewpoint

Process Judging Relevancy/Completeness of Data

Analyzes and evaluates the quality of supporting evidence

Process Drawing Conclusions

Forms a judgment based on premise, evidence, and use of logical reasoning

Recognizing Premises/Structure of Argument

Key

E= Elementary
M= Middle School
S= Senior High

- Skill (M) Assembling Evidence
- Skill (M) Recognizing Fallacies
- Skill (M) Identifying Suppositions
- Skill (S) Identifying Inconsistencies of Logic
- Skill (S) Judging If a Theory is Warranted
- Skill (S) Validity Testing

Recognizing Viewpoint

- Skill (E) Understanding Point of View
- Skill (M) Values Identification
- Skill (M) Recognizing Rhetoric
- Skill (S) Estimating Value Conflicts
- Skill (S) Recognizing Slanted Arguments

Judging Relevancy/Completeness of Data

- Skill (E) Checking for Accuracy and Precision
- Skill (E) Discriminating between Fact and Opinion
- Skill (E) Discriminating between Reality and Fantasy
- Skill (M) Testing Generalizations
- Skill (M) Verifying Information
- Skill (M) Judging Relevance

Key	Skill	(M) Judging the Credibility of a Source
	Skill	(M) Discriminating between Relevant and Irrelevant Data
E= Elementary	Skill	(S) Organizing Data for Effective Use
M= Middle School	Skill	(S) Judging Completeness of Data
S= Senior High	Skill	(S) Detecting Ambiguity

Drawing Conclusions

Skill	(E) Hypothesizing
Skill	(E) Predicting
Skill	(E) Implication Finding
Skill	(E) Evaluating Alternatives
Skill	(E) Generalizing
Skill	(M) Reasoning Inductively
Skill	(M) Reasoning Deductively

Elementary (K-3)**Conceptualize****Process Understanding and Generalizing Concepts**

Skill	Defining (K-3)
Definition	Identifying a word, phrase, or term by stating its precise meaning or significance. Student tells, in his or her own words, the meaning of given terms.
Dispositions	Persistence; (Costa 1984) seeking to be well informed
Sample Activity	Given a list of related terms, some of which are followed by definitions, others only by examples, the student is asked to identify those that are defined. When given five more terms, the student is asked to write accurate and relevant definitions without using examples.
Evaluation Criteria	Precision and accuracy of definition

Process Understanding and Generalizing Concepts

Skill	Paraphrasing (K-3)
Definition	To restate in other words. The student demonstrates understanding of given by translating it into his or her own words.
Dispositions	Persistence; (Costa 1984) seeking to be well informed
Sample Activity	Students will paraphrase events in a fairy tale.
Evaluation Criteria	Clarity in expressing the gist of contents paraphrased

Process	Understanding and Generalizing Concepts
Skill	Describing (K-3)
Definition	To observe and report findings. The student observes both details and "big picture" and accurately and completely reports observations.
Dispositions	Persistence; (Costa 1984) seeking to be well informed
Sample Activity	The student experiments with objects in water to determine which float and which sink. Results are recorded on charts and shared with classmates.
Evaluation Criteria	Accuracy and clarity of reporting

Process	Understanding and Generalizing Concepts
Skill	Attribute Listing (K-3)
Definition	To examine objects or ideas (or groups of objects/ideas) and note essential characteristics. Student generates list of basic elements common to certain objects or ideas.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) using a systematic approach
Sample Activity	Before beginning a unit on bird habitat, the student examines five types of birds and notes that all birds have certain physical attributes such as wings, beak, feet, feathers, etc., in common. Student then hypothesizes common attributes of bird habitats. (For example, habitats are made from materials that can be carried in a beak, etc).
Evaluation Criteria	Lists accurately and completely describes attributes of given object

Process Understanding and Generalizing Concepts

Skill	Patterning (K-3)
Definition	To arrange objects, events, or ideas according to an established or repeated scheme. The student examines materials and recognizes repeated relationships; the student creates repetitions using given materials.
Dispositions	Searching for relationships; (Ennis 1984) using a systematic approach
Sample Activity	Given a set of attribute blocks, the student creates sets of patterns using shape and color.
Evaluation	Consistency of pattern

Process Understanding and Generalizing Concepts

Skill	Understands Spatial Relationships (K-3)
Definition	To grasp relationships between objects and space, as well as between figural representations. Student can orient objects or figures in space.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) willingness to engage in intellectual/aesthetic explorations
Sample Activity	The student uses maps to locate a field trip destination, then writes out directions for the bus driver to use.
Evaluation Criteria	Accuracy of identified spatial connection

Process Understanding and Generalizing Concepts

Skill	Sequencing (K-3)
Definition	To arrange items or events in order according to size, time, or established pattern. The student examines materials and arranges in order.
Dispositions	Searching for relationships; (Ennis 1984) using a systematic approach
Sample Activity	Given six pictures of events from the story <i>Little Red Riding Hood</i> , the student sequences them in relationship to each other according to the time they happened in the story.
Evaluation Criteria	Correctness of sequence

Process	Understanding and Generalizing Concepts
Skill	Classify (K- 3)
Definition	To organize items into clusters according to common characteristics and to label each cluster. The student sorts information by putting those items with common characteristics into the same group and develops labels for the groups.
Dispositions	Searching for relationships; (Ennis 1984) using a systematic approach
Sample Activity	The student sorts a variety of animal pictures into two or more groups and labels each group (furry animals, jungle animals, zoo animals, etc.).
Evaluation	•Accuracy of sorting •Appropriateness of labels

Process	Understanding and Generalizing Concepts
Skill	Compare and Contrast (K-3)
Definition	To examine objects or ideas in order to note similarities and differences. The student examines materials and identifies like and unlike features.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) using systematic approaches
Sample Activity	The student notes similarities and differences between Paddington Bear and Winnie the Pooh.
Evaluation Criteria	Accuracy of observations

Process Understanding and Generalizing Concepts

Skill	Categorizing (K-3)
Definition	To group items according to predetermined criteria. Given certain criteria, the student arranges items into sets.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) using systematic approaches
Sample Activity	The student groups dinosaurs into carnivore and herbivore categories.
Evaluation Criteria	Assignment of items to appropriate categories

Process Understanding and Generalizing Concepts

Skill	Summarizing (K-3)
Definition	To present the substance of a complex idea in a shorter, less detailed, more concise form. Student isolates central idea of written or oral presentation or problem situation.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) reflective behavior
Sample Activity	After reading a story in the reading text, the student writes two to three line character sketches of main characters.
Evaluation Criteria	•Comprehensiveness of idea presented as central •Conciseness of ideas presented

Process	Transforming Concepts
Skill	Understanding and inferring relationships (K-3)
Definition	To arrive at a conclusion that evidence points to but does not absolutely establish. The student bases tentative conclusions on incomplete but suggestive data.
Dispositions	Flexibility of thought, searching for relationships, using systematic approaches
Sample Activity	The student will determine possible conclusions for an <i>Encyclopedia Brown</i> mystery based on the evidence presented in the story.
Evaluation Criteria	•Accuracy of conclusions generated from given information •Directness of link between given information and generated conclusions

Elementary K-3**Produce****Process****Ideation****Skills**

Fluency, flexibility, originality

Definition

Produces ideas in a fluent, flexible manner.

Dispositions

Risk taking, curiosity, complexity, imagination, openness

Grades K-1**Sample Activity**

Students list playground safety rules.

Evaluation Criteria

- Number of ideas produced
- Variety of perspectives

Grade 2**Sample Activity**

Students suggest alternative endings for a story they are reading.

Evaluation Criteria

- Number of ideas produced
- Variety of perspectives

Grade 3**Sample Activity**

Students list "children's rights."

Evaluation Criteria

- Number of ideas produced
- Variety of perspectives

Process**Visualization****Skills**

Originality

Definition

Develops mental pictures or images to discover new ideas, interpret symbols and solutions to problems and challenges. (Adapted from Eberle 1982)

Dispositions	Risk-taking, complexity, curiosity, imagination
Grades K-1	
Sample Activity	Students with as few lines as possible "sketch" the roles and responsibilities of the family members.
Evaluation Criteria	Clarity of symbols used to produce sketch
Grade 2	
Sample Activity	Students with as few lines as possible "sketch" the habitat, predators, and food source of forest animals.
Evaluation Criteria	•Clarity, originality of symbols used to produce sketch •Congruence of response to given stimulus image
Grade 3	
Sample Activity	•Students "sketch" with as few lines as possible the sequence of events in one of their reading stories. •Students "sketch" a factual report on an animal's habitat and life cycle.
Evaluation Criteria	•Clarity of symbols, concepts •Ordered progression of relationships •Accuracy of elaborate detail added to imaged object/environment
Process	Invention
Skills	Flexibility, originality, elaboration, abstraction, schemata, heuristics (Perkins 1981)
Definition	Searches and selects ideas, devises and revises plans that improve or innovate.
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, intuitiveness, and critical reasoning (Perkins 1981)

Grades K-1

Sample Activity	Students locate and describe items in their households which can be improved. Students describe the problems they have with the particular item.
Evaluation Criteria	Validity of object selected for problem/improvement

Grade 2

Sample Activity	Students identify a household object that has a design problem. Students draw the product with appropriate improvements.
Evaluation Criteria	•Validity of selection •Practicality of improvement

Grade 3

Sample Activities	Choose two of the following items to combine: skateboard, wood box (crate), rake, fishing rod, egg beater, garden hose. How would this new invention be used? Draw and label your new invention. Write a paragraph describing its function.
Evaluation Criteria	•Validity of selection •Practicality of improvement •Originality of combination •Practicality of product

Process Synectics

Skills	Flexibility, originality, elaboration, abstraction
Definition	Compares objects or ideas.
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity

Grades K-1

Sample Activity	Which is smarter 7 or 3? Why? What color is happiness? Why?
Evaluation Criteria	Degree of correspondence between elements

Grade 2

Sample Activity	Which is stronger a smile or a frown? Why? Which is prouder, the Statue of Liberty or a desert lizard? Why?
Evaluation Criteria	Degree of correspondence between the elements

Grade 3

Definition	Compares and contrasts two parallel ideas using direct analogy
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981), critical reasoning (Perkins 1981)
Sample Activity	Which forest animal is most like you? Why?
Evaluation Criteria	Congruence of elements with the construct

Process Planning

Skills	Flexibility, Elaboration, Heuristics (Perkins 1981)
Definition	Perceives or acts effectively by anticipating the organization, involves both perception and production. (Perkins 1981)
Dispositions	Risk-taking, complexity, openness, direct remembering, (Perkins 1981) critical reasoning (Perkins 1981)

Grades K-1

Sample Activity	During a pet unit, students plan the adoption of a new pet. They determine supplies needed and new tasks demanding responsibility.
Evaluation Criteria	Completeness of steps to be taken, resources needed

Grade 2

Sample Activity	After a study of plant life, students begin their own seedlings. Each student determines soil content, amount of sunlight, water, etc.
Evaluation Criteria	Adequacy of designed procedure

Grade 3

Sample Activity	Students determine appropriate safety procedures/precautions for a field trip to a local nature center.
Evaluation Criteria	•Adequacy of procedure •Validity of evaluated criteria

Process	Evaluation
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Skills	Flexibility, Elaboration, Abstraction, Schemata, (Perkins 1981) Heuristics (Perkins 1981)
Definition	Judges an idea to see whether it is going to work, looks at criteria, advantages and disadvantages (De Bono 1970)
Dispositions	Complexity, openness, intuitiveness (Perkins 1981) critical reasoning (Perkins 1981)

Grades K-1

Sample Activity	Students select criteria for wise use of their allowance/birthday money.
Evaluation Criteria	Number of criteria selected; comprehensiveness of criteria

Grade 2

Sample Activity	Students decide which forest animal they would choose to be based on individually determined criteria.
Evaluation Criteria	Appropriateness of criteria selected; comprehensiveness of criteria.

Grade 3

Sample Activity	Which would be a more appropriate gift for a grandmother who lives alone -a cat or a color television? List the advantages and disadvantages of each gift.
Evaluation Criteria	•Balance of positive/negative criteria; number of criteria •Objectivity of categorization; balance; comprehensiveness

Process	Problem Finding
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Skills	Fluency, Flexibility, Originality, Abstraction, Schemata, (Perkins 1981), Heuristics (Perkins)
Definition	Uses fact finding, problem identification, idea production, solution finding in the development of an action plan. (Parnes, Osborn 1970)
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)

Grades K-1

Sample Activity	Students determine alternative solutions to Little Red Riding Hood's problem of identifying her "real" grandmother.
Evaluation Criteria	Number of problems identified

Grade 2

Dispositions	Complexity, openness, critical reasoning (Perkins 1981)
Sample Activity	Students identify specific problems related to environmental dangers to a local pond.
Evaluation Criteria	Number of problems identified

Grade 3

Dispositions	Risk-taking, complexity, curiosity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Students determine ways America can share its wealth of resources with other countries.
Evaluation Criteria	Accuracy of problem identification; comprehensiveness

Process Creative Problem Solving Model

Skills	Fluency, Flexibility, Originality, Abstraction, Schemata, (Perkins 1981) Heuristics (Perkins 1981)
Definition	Uses fact finding, problem identification, idea production, solution finding in the development of an action plan. (Parnes 1981)
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 2*

Sample Activity	Students identify possible ways to outscheme the wolf in the <i>Three Little Pigs</i> .
Evaluation Criteria	Appropriateness of selected alternative solutions

*Creative Problem Solving Model begins in grade 2.

Grade 3

Sample Activity	Students identify alternative solutions to a problem situation in a story selected by the student.
Evaluation Criteria	Appropriateness of selected alternative solutions

Elementary (K-3)**Evaluation****Process Recognizing Premises/Structure of the Argument**

Skill Hypothesizing (K-3)

Definition To use logic to develop an "if...then" statement that proposes a possible or likely relationship between certain phenomena and their consequences. Given certain circumstances or observable occurrences, the student proposes further circumstances that are likely to result.

Dispositions Displays intellectual curiosity, (Ennis 1984) flexibility of thought, searching for relationships, (Ennis 1984) willingness to engage in intellectual/aesthetic explorations

Sample Activity In a social studies unit titled "Wants and Needs", students complete the following statements: "If I get everything I want for my birthday, then..." "If I only put items I need on my birthday list, then..."

Evaluation Criteria Logic of the link between the if...then suppositions

Process Recognizing Premises/Structure of the Argument

Skill Detecting Assumptions (K-3)

Definition To recognize that a supposition is being made or that a supposition underlies a statement. The student is able to determine when a statement or position is based on data and when it is based on an assumption

Dispositions Flexibility of thought, searching for relationships, (Ennis 1984) using systematic approaches, persistence (Costa 1984)

Sample Activity In a lesson on giving clear directions, the teacher instructs the class that after he or she steps out for a moment, the class is to choose a simple task for the teacher to complete on his or her return. (Open the closet door, draw a circle on the black board, etc.) Upon the teacher's return, one student is to break the task down into its component parts, and without stating the final objective, is to begin giving directions (walk, turn left, etc.). At each instruction, the teacher is alert for chances to make an assumption. (At the instruction "walk", the teacher walks briskly, turning often.) When the student objects, the teacher says, "I assumed you meant to walk in many directions until I reached the correct choice." The exercise continues in this manner until the final objective is reached.

Evaluation Criteria Accuracy and comprehensiveness in recognizing assumptions

Process Recognizing Viewpoint	
Skill	Understanding Point of View (K-3)
Definition	To have an awareness that differing interests, knowledge, background, or values can result in differences of perception or interpretation. The student is able to identify the relationship between physical, environmental, emotional, intellectual, and cultural factors, and the perception and interpretation of events.
Dispositions	Being open-minded, (Ennis 1984) respecting viewpoints of others, (Ennis 1984) willingness to engage in intellectual/aesthetic explorations
Sample Activity	In a unit on westward expansion, students are asked to describe an event of the time from the viewpoint of the pioneer and the Native American.
Evaluation Criteria	Accuracy of description of relationship between individual variables and viewpoint expressed

Process Judging Relevancy/Completeness of Data	
Skill	Checking for Accuracy and Precision (K-3)
Definition	To examine for correctness and exactness. The student examines his or her own work, or the work of others, for the purpose of eliminating errors and improving clarity of thought and effectiveness of communication.
Dispositions	Using systematic approach, persistence (Costa 1984)
Sample Activity	During writing labs, the student exchanges rough drafts with at least two other students who make proofreading and editing suggestions which may be used in the revision stage.
Evaluation Criteria	•Thoroughness of checking process •Improvement of examined product

Process Judging Relevancy/Completeness of Data

Skill Discriminating Between Fact and Opinion (K-3)

Definition	To distinguish between statements generally accepted as true and those which are based on personal or unsubstantiated assumptions. The student distinguishes between objective and subjective claims.
Dispositions	Using a systematic approach, seeking to be well informed
Sample Activity	Shown a videotape of a cereal commercial, the student lists those claims that can be verified and those that cannot.
Evaluation Criteria	Accuracy of conclusions

Process Judging Relevancy/Completeness of Data

Skill	Discriminating Between Reality and Fantasy (K-3)
Definition	To distinguish between that which is true or actual and that which is illusory, fictitious, or imaginative.
Dispositions	Displays intellectual curiosity, (Ennis 1984) using systematic approaches, reflective behavior
Sample Activity	The student observes and records the behavior of live ladybugs. The student then determines which of the behaviors described or pictured in <i>The Grouchy Ladybug</i> are consistent with his or her observation and which are clearly fantasy.
Evaluation Criteria	Accuracy and completeness of distinctions

Process Drawing Conclusions

Skill	Predicting (K-3)
Definition	To formulate possible consequences of an event or series of events. Student uses his or her knowledge to project possible outcomes
Dispositions	Flexibility of thought, searching for relationships, (Ennis 1984) using systematic approaches

Sample Activity	Student predicts which of three objects dropped simultaneously from a height of three feet will hit the ground first
Evaluation Criteria	•Logic of described outcome •Directness of link between given information and prediction

Process Drawing Conclusions

Skill	Implication Finding (K-3)
Definition	To recognize possible consequences or results of an event or an idea. The student predicts possible outcomes of an event
Dispositions	Flexibility of thought, searching for relationships, (Ennis 1984) using systematic approaches
Sample Activity	Using an effects wheel, the student generates possible changes in American life resulting from a strike by garbage collectors.
Evaluation Criteria	•Accuracy of implication recognition •Comprehensiveness of implications identified

Process Drawing Conclusions

Skill	Evaluating Alternatives (K-3)
Definition	To explore different approaches to the solution of problems. Given established criteria, the student determines the relative merit of possible actions
Dispositions	Displays intellectual curiosity, (Ennis 1984) being open-minded, (Ennis 1984) using systematic approaches

Sample Activity	When choosing a field trip site, students are asked to compare various options as to cost, enjoyment, and exposure to new ideas.
Evaluation Criteria	•Clarity of link between criteria and evaluation •Uniformity of judgments
Process	Drawing Conclusions
Skill	Generalizing (K-3)
Definition	To form broad conclusions from supporting evidence. When presented with certain facts, the student generates possible conclusions or outcomes.
Dispositions	Flexibility of thought, searching for relationships, reflective behavior
Sample Activity	After reading an incomplete mystery story, the student devises one or more possible endings which adequately explain the mystery.
Evaluation Criteria	Directness of link between evidence and conclusion

Conceptualize

Process Understanding and Generalizing Concepts

Skill	Ordering Priorities (4-8)
Definition	To rank objects, ideas, persons, conditions, or events by importance or personal preference. The student arranges items according to pre-established value or personal value.
Dispositions	Using systematic approaches; respecting viewpoints of others; (Ennis 1984) reflective behavior
Sample Activity	The student examines the contents of his or her desk and ranks the contents from most to least valuable in solving a particular problem. The teacher then presents another problem and asks the student to reorder the materials
Evaluation Criteria	Ability to defend rankings based on logic

Process Understanding and Generalizing Concepts

Skill	Explaining Ideas Clearly (4-8)
Definition	To make ideas plain or comprehensible. The student evidences clarity of thought and usage in oral and written communication.
Dispositions	Flexibility of thought; searching for relationships; (Ennis 1984) reflective behavior

Sample Activity	The student writes clear, concise, understandable directions to a particular point in the school. To check for quality of explanation another student follows the directions and critiques them.
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Evaluation Criteria	Clarity of explanation
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Process	Understanding and Generalizing Concepts (Conceptualize)
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Skill	Formulating (4-8)
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Definition	To acquire information for the purpose of knowledge acquisition, clarification, or verification. Student poses questions designed to make a situation clearer or more understandable.
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Dispositions	Displays intellectual curiosity; (Ennis 1984) seeking to be well informed
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Sample Activity	As a homeroom activity, class participates in "Expert For A Day." Once weekly, the student designated as "expert" for that day chooses a topic with which he or she is familiar. Classmates take turns asking questions regarding that topic, sometimes asking for new information, sometimes seeking clarification or building on the questions of others.
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Evaluation Criteria	•Comprehensiveness of information collected •Directness of link between topic and questions •Reduction of confusion
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Process	Transforming Concepts
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Skill	Using Analogies (4-8)
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Definition	To draw comparisons by generating parallels. The student notes similarities between given objects, concepts or situations while also discerning that differences exist.
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Dispositions	Flexibility of thought, searching for relationships, being open-minded
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Sample Activity	Students note similarities between a mechanical pump and a human heart.
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Evaluation Criteria	•Logic used in generation of a comparison •Accuracy of details used in comparison
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Process	Transforming Concepts
Skill	Using Metaphors (4-8)
Definition	To use figures of speech or images to show meaning by comparison or analogy as in "evening of life." To draw comparisons by generating parallels.
Dispositions	Flexibility of thought, searching for relationships, being open-minded
Sample Activity	Students compare seasons of the year with stages of their lives.
Evaluation Criteria	•Logic used in generation of a comparison •Accuracy of details used in comparison

Process	Transforming Concepts
Skill	Designing Experiments (4-8)
Definition	To develop a test for the purpose of demonstrating a known truth or examining the validity of a hypothesis. The student develops hypotheses and procedures that will verify or disprove those hypotheses.
Dispositions	Displays intellectual curiosity; (Ennis 1984) flexibility of thought; using systematic approaches; willingness to engage in intellectual/aesthetic explorations
Sample Activity	The student designs an experiment that answers the question, "Who has faster heart rates, eighth-grade boys or eighth-grade girls?"
Evaluation Criteria	•Adequacy of design for testing a given hypothesis •Systematic use of testing procedure

Process	Transforming Concepts
Skill	Analyzing Trends (4-8)
Definition	To recognize the pattern/sequence of a given body of information. The student identifies a pattern in given material and checks it for consistency.

Dispositions	Being open-minded, flexibility of thought, searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	Given graphs showing the average temperature in Minnesota for the past fifteen years, the student determines if there is a rising, falling, or stable trend and relates conclusion to media coverage of global warming.
Evaluation Criteria	•Appropriate organization of data •Accuracy of trend interpretation
Process	Transforming Concepts
Skills	Synthesizing Information (4-8)
Definition	To combine single elements into a complex whole. The student combines pieces of information or data in such a way that part/whole relationships, patterns, or global understandings are recognized.
Dispositions	Flexibility of thought, searching for relationships, using systematic approaches
Sample Activity	Given criteria regarding cell structure, habitat, locomotion, reproductive system, and means of obtaining nutrients, the student will design a creature that meets those criteria. The student may then present a scientific paper in a class "symposium" as if he or she had discovered the animal.
Evaluation Criteria	Accuracy and clarity of insight reached

Middle School (4-8)

Produce

Ideation

Skill	Fluency, Flexibility, Originality
Definition	Produces ideas in a fluent, flexible manner
Dispositions	Risk-taking, curiosity, complexity, imagination, openness

Grade 4

Sample Activity	Students list examples of opinion, fact, prejudice, and fantasy in mass communication.
Evaluation Criteria	Number of ideas produced, variety of perspectives

Grade 5

Sample Activity	Students list items which use the metric system as a method of measurement.
Evaluation Criteria	•Number of ideas produced; variety of perspectives. •Pertinence of ideas produced

Grade 6

Sample Activity	Students identify ways our culture has been influenced by ideas or inventions of ancient civilizations.
Evaluation Criteria	Number of interrelated ideas produced, pertinent to given problem

Grade 7

Sample Activity	Students identify reasons for adolescent involvement in drugs and alcohol.
Evaluation Criteria	•Number of high quality, pertinent ideas to given problem/situation

Grade 8

Sample Activity	Students identify alternative endings for a Sherlock Holmes mystery.
Evaluation Criteria	•Number of congruent ideas: detail; quality

Process Visualization

Skill	Originality
Definition	Develops mental pictures or images to discover new ideas, interprets symbols and concepts, find solutions to problems and challenges. (Adapted from Eberle 1982)
Dispositions	Risk-taking, complexity, curiosity, imagination

Grade 4

Sample Activity	•After an opportunity to imagine a story line, students "sketch" events in an original tall tale. •Students design an original symbol system for maps using the principles of minimal details of sketching. •Students as a group "cognitively map" (chart, cluster) the content of a social studies chapter.
Evaluation Criteria	•Clarity, originality, order, wholeness of sketch •Consistency of symbols used to elaborate image; degree to which image may be accessed by peers •Comprehensiveness of cognitive map; accuracy of relationships mapped

Grade 5

Sample Activity	•Students "sketch" their hypothesis for motion and force experiments. •Students individually map their health unit on body systems.
Evaluation Criteria	•Clarity, order, wholeness of sketch •Consistency, accessibility of image produced •Comprehensiveness, accuracy of relationships mapped

Grade 6

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|---------------------|---|
| Sample Activity | <ul style="list-style-type: none">•Students identify an environmental issue and complete a futures wheel of cause and effect, visualizing potential outcomes.•Students chart physical and chemical changes using the sketching method. |
| Evaluation Criteria | <ul style="list-style-type: none">•Clarity, order, wholeness of sketch•Consistency, accessibility of images produced•Comprehensiveness, accuracy of implications mapped |

Grade 7

- | | |
|---------------------|--|
| Sample Activity | Students use imagination as a method of isolating body parts and envisioning a relaxed state as an aid in stress management. |
| Evaluation Criteria | <ul style="list-style-type: none">•Clarity, order, wholeness of sketch•Focus, depth, elaborate detail of image stimulus•Comprehensiveness, accuracy of implications mapped |

Grade 8

- | | |
|---------------------|---|
| Sample Activity | Students visualize and sketch potential solutions to problems of both personal and academic nature. |
| Evaluation Criteria | <ul style="list-style-type: none">•Clarity, order, wholeness of sketch; extended use of sketch in final production•Variety of uses to which imaging is put; originality of applications•Comprehensiveness, accuracy of mapped elements, depth of concept mapped, organizational capacity of map |

Process	Invention
	Grade 4
Skills	Flexibility, originality, elaboration, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)
Definition	Searches and selects ideas, devises and revises plans that improve or innovate. (Perkins 1981)
Dispositions	Risk-taking, complexity, imagination, curiosity, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Students are introduced to the idea checklist SCAMPER (Eberle 1977). Students are then asked to select an item from a grab bag of household utensils using SCAMPER to produce ideas. Students invent a new device.
Evaluation Criteria	•Simplicity, sophistication of improvements made •Practicality of product; elaborate detail provided for combination •Use of all SCAMPER processes on given stimulus
	Grade 5
Dispositions	Risk-taking, complexity, curiosity, imagination, openness
Sample Activity	Students plan a workable design for a mechanical home garden tool.
Evaluation Criteria	•Simplicity, sophistication; validity of criteria selection for product evaluation •Practicality, degree of elaborative detail; finished quality of product •Use of all SCAMPER processes on given stimulus •Practicality of mechanical product devised
	Grade 6
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Students design an organizational plan for cleaning a messy room.
Evaluation Criteria	•Simplicity, sophistication, evaluation criteria validity workability of finished product •Practicality; degree of elaborative detail; finished quality of product •Effectiveness of use of all SCAMPER processes on given stimulus •Workability, viability of mechanized product •Ordered progression of steps; clarity of step descriptions

Grade 7

The next level of sophistication of the invention process does not occur until grade 9

Grade 8

The next level of sophistication of the invention process does not occur until grade 9

Process Synectics

Skills Flexibility, originality, elaboration, abstraction

Grade 4

Definition	Compares and contrasts two parallel ideas using direct analogy.
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Which character in the book is most like you? Unlike you? Why?
Evaluation Criteria	Congruence of elements with third construct

Grade 5

Definition	Describes in first person an emotion using personal analogy. (Gordon, Poze 1975)
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	When I am (name an emotion) I am like a cheetah because.....
Evaluation Criteria	•Congruence •Elaboration, validity of self-perception

Grade 6

Definition	Empathizes with a living thing evoking both emotional and kinesthetic involvement through personal analogy. (Gordon, Poze 1975) Empathizes with a non-living object through personal analogy. (Gordon, Poze 1975)
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Describe how a whale feels as he or she is hunted.
Evaluation Criteria	•Congruence •Elaboration, validity of self-perception

Grade 7

Skills	Flexibility, originality, elaboration, abstraction
Definition	•Compares two word descriptions encompassing words in conflict, i.e., peaceful terror, careful collision through symbolic analogy. (Gordon, Poze 1975) •Empathizes with a living thing evoking both emotional and kinesthetic involvement through personal analogy (Gordon, Poze 1975)
Dispositions	Risk-taking, complexity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	What is an example of joyful fear? Explain. Describe the viewpoint of the Native American as the colonists pushed westward.
Evaluation Criteria	•Congruence •Elaboration, validity •Validity of connection with symbolic construct

Grade 8

All levels of sophistication of the synectics process are complete by grade 7.

Process Planning

Skills	Flexibility, elaboration, heuristics (Perkins 1981)
Definition	Perceives or acts effectively by anticipating the organization, involves both perception and production.
Dispositions	Risk-taking, complexity, openness, direct remembering, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 4

- Sample Activity After a geography unit, students plan and map "newly discovered" island.
- Evaluation Criteria Relevance of criteria for open-ended product

Grade 5

- Sample Activity After a study of Latin America, students determine cultural and environmental adjustments should they move there.
- Evaluation Criteria
 - Practicality of personal solution/product
 - Correctness of knowledge application

Grade 6

- Sample Activity
 - Students identify an environmental issue and complete a futures wheel of cause and effect visualizing potential outcomes.
 - Students chart physical and chemical changes using the sketching method.
- Evaluation Criteria
 - Clarity, order, wholeness of sketch
 - Consistency, accessibility of images produced
 - Comprehensiveness, accuracy of implications mapped

Grade 7

- Sample Activity Given the environmental conditions of an ecosystem, students analyze the effects of pollution of the food webs and populations of the various species.
- Evaluation Criteria Accuracy in recognition of patterns in complex stimulus field

Grade 8

- Sample Activity After study of artistic styles characteristic of different schools and eras, students render original drawings reflecting application of these styles.
- Evaluation Criteria
 - Accuracy in interpretation of patterns in complex stimulus field
 - Validity of application

Process	Evaluation
Skills	Flexibility, elaboration, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)
Definition	Judges an idea to see whether it is going to work, looks at criteria, advantages and disadvantages. (De Bono 1970)
Dispositions	Complexity, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Grade 4	
Sample Activity	Students believe that they should have a longer recess, however, this means another class would need to be shortened. Which class would it be? Is this an appropriate plan? What are the advantages and disadvantages?
Evaluation Criteria	•Relevance of application to personal experience; objectivity of criteria selection •Comprehensiveness of judgment; balance •Practicality of solution, based on evaluation
Grade 5	
Sample Activity	Students list advantages and disadvantages of being president, then determine criteria for being a good president.
Evaluation Criteria	•Comprehensiveness of abstract criteria selection •Balance; validity of positive/negative categorization; objectivity in categorization
Grade 6	
Dispositions	Complexity, openness, critical reasoning (Perkins 1981)
Sample Activity	A child advocacy group believes toys depicting or encouraging violence should be removed from toy departments. What are the advantages/disadvantages? What criteria might be established for appropriate playthings?
Evaluation Criteria	•Comprehensiveness; congruence to given of problem/solution •Balance, objectivity, validity of categorizations
Grade 7	
Dispositions	Complexity, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Analyze the advantages and disadvantages of urban, suburban, and country living. Determine your criteria for a satisfying place to live and decide where you are best suited to reside.
Evaluation Criteria	•Comprehensiveness; congruence applicability of criteria across solution levels •Balance, objectivity, validity of categorizations

Grade 8

Dispositions	Complexity, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)
Sample Activity	Students investigate product claims by conducting their own consumer research, they make recommendations on a variety of products based on advantages/disadvantages and criteria established by the group.
Evaluation Criteria	Comprehensiveness; congruence; applicability

Process Problem Finding

Skills	Flexibility, abstraction
Definition	Narrows a problem situation, proceeds to identification of an underlying problem. (Perkins 1981)
Dispositions	Complexity, openness, critical reasoning (Perkins 1981)

Grade 4

Sample Activity	Students identify community problems related to the high use of the Minneapolis/St. Paul airport. They then identify the underlying problem.
Evaluation Criteria	Accuracy of problem identification; comprehensiveness

Grade 5

Sample Activity	Students list problems related to increased use of technology in schools, then identify the underlying problem.
Evaluation Criteria	Accuracy of problem identification; comprehensiveness

Grade 6

Sample Activity	Students identify problems related to world hunger, then identify the underlying problem.
Evaluation Criteria	Accuracy of problem identification; comprehensiveness

Grade 7

Sample Activity	Students identify problems related to the position of Black Americans during the time of the setting of Tom Sawyer and today. They determine the underlying problem then and today.
Evaluation Criteria	Accuracy in problem identification across multiple situations, levels

Grade 8

Sample Activity	Students identify problems related to the current farm crisis and discuss the underlying problem.
Evaluation Criteria	Accuracy in problem identification across multiple situations, levels

Process Creative Problem Solving Model

Skills	Fluency, flexibility, originality, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)
Definition	Uses fact finding, problem identification, idea production, solution finding in the development of an action plan. (Parnes 1981)
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 4

Sample Activity	Students identify ways in which the resources of the ocean can be more effectively used.
Evaluation Criteria	•Number of alternatives produced; variety of perspectives, appropriateness of solutions in solving "problem" •Completion of CPS steps; adequacy of chosen solution

Grade 5

Sample Activity	Using the five-step CPS process, students determine ways to resolve the North/South conflict prior to the Civil War.
Evaluation Criteria	•Number of alternatives produced; variety of perspectives appropriateness of solutions in solving "problem" •Appropriate use of CPS on historically/academically based problems

Grade 6

Sample Activity Using CPS, students determine alternative methods for saving an endangered species.

Evaluation Criteria

- Number, variety of alternatives produced; originality of solutions
- Appropriate use of CPS on environmental/scientific issues or problems

Grade 7

Sample Activity Using CPS, students identify an alternative method of solving a problem for a current world situation.

Evaluation Criteria Number, variety, originality

Grade 8

Sample Activity Students identify ways in which America may increase the number of potential inventions. They develop an action plan applying their best solution.

Evaluation Criteria Number, variety, originality, practicality

Process Recognizing Premises/Structure of Argument

Skill	Assembling Evidence (4-8)
Definition	To gather information for the purpose of proving or disproving an idea or assertion or for the purpose of supporting an argument. The student identifies, collects, and evaluates the evidence needed to support or disprove a position.
Dispositions	Searching for relationships, reflective behavior, persistence, seeking to be well informed
Sample Activity	Given a common position statement such as "pollution is destroying the ozone layer," the student collects data regarding that statement and organizes it into categories of supporting evidence and evidence to the contrary.
Evaluation Criteria	•Comprehensiveness of research •Relevancy of data chosen for use

Process Recognizing Premises/Structure of Argument

Skill	Recognizing Fallacies (4-8)
Definition	To note an error in the thinking process. The student uses previously mastered critical thinking skills to recognize illogical reasoning and/or false conclusions.
Dispositions	Using systematic approaches, reflective behavior, persistence
Sample Activity	The student reconstructs the thinking which might have led to fallacious beliefs such as "Only homosexuals and drug users need to be concerned with getting AIDS," or "Cancer is a fatal illness." The student then refutes the statement.
Evaluation Criteria	Accuracy of recognition of fallacious argument

Process	Recognizing Viewpoint
Skill	Values Identification (4-8)
Definition	To recognize individual and group preferences, orientations, and ideologies. The student recognizes a value orientation as a direction of thought or inclination formed by one's belief system. The student recognizes an ideology as a manner of thinking or a concept held that is characteristic of an individual or a group.
Dispositions	Displays intellectual curiosity, being open-minded, (Ennis 1984) seeking to be well informed, respects viewpoint of others, willingness to engage in intellectual/aesthetic explorations
Sample Activity	The student compares and contrasts the views of archeologists and the views of Native Americans regarding the excavation of Indian burial sites.
Evaluation Criteria	•Accuracy of values recognition •Absence of personal values imposition

Process	Recognizing Viewpoint
Skill	Recognizing Rhetoric (4-8)
Definition	To recognize that certain communication strategies emphasize style or effect at the expense of thought. The student understands and recognizes techniques such as propaganda, bias, semantic slanting, cliché, and stereotype.
Dispositions	Searching for relationships, flexibility of thought, using systematic approaches
Sample Activity	•While viewing a videotape of an (appropriate) episode of "All In The Family," the student documents examples of rhetoric. •Given samples of speeches made by George Bush and Jesse Jackson, the student compares and contrasts rhetorical techniques used.
Evaluation Criteria	•Correctness of identification of rhetorical techniques •Completeness of techniques identified

Process	Judging Relevancy/Completeness of Data
Skill	Testing Generalizations (4-8)
Definition	To determine which facts support a generalization and which refute it. The student identifies and verifies the pieces of information which support a statement, law, or principle as well as those which call it into question.
Dispositions	Searching for relationships, using systematic approaches, seeking to be well informed
Sample Activity	Given the statement "Rules are made for our own good," the student examines rules of the school and determines who most benefits from each.
Evaluation Criteria	•Completeness of information gathered •Accuracy of conclusions drawn

Process	Judging Relevancy/Completeness of Data
Skill	Verifying Information (4-8)
Definition	To distinguish between data that can be substantiated and data that cannot; to confirm data when appropriate. The student distinguishes between those "facts" that can be confirmed and those whose accuracy cannot be confirmed.
Dispositions	Searching for relationships, using systematic approaches, seeking to be well informed
Sample Activity	The student records the claims made on five different brands of cereal regarding taste, nutritional value, etc., and determines which of those could be verified through data collection and experimentation, and which of those could not be verified.
Evaluation Criteria	Accuracy of distinctions made between verifiable and unverifiable data

Process	Judging Relevancy/Completeness of Data
Skill	Judging Relevance (4-8)
Definition	To decide whether or not data are connected with and are useful to the solution of a problem. The student differentiates between information that is basic, essential, or necessary to the solution of a problem, and information that arises without intention or as a minor consequence of an event.
Dispositions	Flexibility of thought, searching for relationships, using systematic approaches, seeking to be well informed
Sample Activity	When writing up the results of a science experiment, the student distinguishes between evidence which answers the original problem and incidental information gathered along the way.
Evaluation Criteria	Use of essential data, discarding of inessential data

Process	Judging Relevancy/Completeness of Data
Skill	Judging the Credibility of a Source (4-8)
Definition	To determine the authenticity of the credentials of a giver of information. The student recognizes that a credible source has expertise, lack of conflict of interest, supporting evidence, and agreement with other sources.
Dispositions	Using systematic approaches, respecting the viewpoints of others, (Ennis 1984) seeking to be well informed
Sample Activity	Given samples of claims from the Surgeon General and a tobacco company representative regarding the effects of tobacco use, the student researches each source and evaluates expertise, possible bias, and supporting evidence.
Evaluation Criteria	•Comprehensiveness of research into source •Accuracy of conclusions drawn

Process Judging Relevancy/Completeness of Data

Skill	Discriminating Between Relevant and Irrelevant Data (4-8)
Definition	To sort information into two categories: items applicable to the matter at hand and items inapplicable. The student determines usefulness of specific pieces of information in the solving of a particular problem.
Dispositions	Searching for relationships, using systematic approaches, seeking to be well informed
Sample Activity	During a simulation in a geography unit, the student is given a list of characteristics about a fictional country and asked to determine which should be considered when determining what crops will be part of the agricultural plan for the country.
Evaluation Criteria	•Correctness of sorting process •Logic used in sorting process

Process Drawing Conclusions

Skill	Reasoning Inductively (4-8)
Definition	To draw tentative conclusions by combining known facts with assumptions or hypotheses. The student reaches a possible conclusion by combining known facts with existing ideas or suppositions.
Dispositions	Flexibility of thought, being open-minded, searching for relationships, using systematic approaches
Sample Activity	The student completes the activity given under deductive reasoning regarding acids and bases. The student also studies neutralization. He or she is then given three samples of commercially prepared antacid tablets and determines which of those is "best." (The term "best" is deliberately vague in order to allow students to establish their own criteria using their own hypotheses and assumptions.)
Evaluation Criteria	•Accuracy of identification of stated or unstated assumptions •Reasonableness of conclusion reached based on stated or unstated assumptions

Process	Drawing Conclusions
Skill	Reasoning Deductively (4-8)
Definition	To draw conclusions from known facts. The student reaches an irrefutable conclusion based on the combining or ordering of known facts.
Dispositions	Searching for relationships, using systematic approaches, persistence, willingness to engage in intellectual/aesthetic explorations
Sample Activity	The student is given two containers. Container A holds an acid, container B a base. The student is also given litmus paper, magnesium metal, and the information that a base feels slippery to the touch. Students experiment with the supplies, then write a "definition" of acid and base by describing experimental outcomes. (A base turns litmus red, feels like water, and fizzes when mixed with magnesium metal.)
Evaluation Criteria	•The conclusion reached is directly linked to the facts presented and only to the facts presented •Accuracy of conclusion reached

High School (9 - 12)**Produce****Process****Ideation****Skills**

Fluency, flexibility, originality

Definition

Produces ideas in a fluent, flexible manner.

Dispositions

Risk-taking, curiosity, complexity, imagination, openness

Grade 9**Sample Activity**

Students determine applications of algebra in everyday life.

Evaluation Criteria

Number of congruent ideas, details; quality

Grade 10**Sample Activity**

Students apply idea production to everyday use by determining appropriate questions for an informational career interview.

Evaluation Criteria

Quality, congruence of ideas; practicality, feasibility of generated ideas

Grade 11**Sample Activity**

Students identify ways the U.S. and Canada could cooperate to curtail the increasing incidence and effects of acid rain.

Evaluation Criteria

Quality, congruence of ideas; practicality, feasibility of generated ideas

Grade 12**Sample Activity**

Students use idea production to identify cause/effect relationships in the increased capitalization in the Soviet Union.

Evaluation Criteria

Quality, congruence of ideas; practicality, feasibility of generated ideas

Process**Invention****Skills**

Flexibility, originality, elaboration, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)

Definition

Searches and selects ideas, devises and revises plans that improve or innovate. (Perkins 1981)

Dispositions

Risk-taking, complexity, curiosity, imagination, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 9

Sample Activity	Students design original vehicles illustrating fundamentals of uniform and accelerated motion.
Evaluation Criteria	•Degree of change in revision, self-checking •Originality, appearance, balance among elements •Effectiveness of use, originality of modification •Workability, durability •Order, clarity, relevance to personal life

Grades 10-12

All levels of sophistication of the invention process are complete by grade 9.

Process Planning

Skills	Flexibility, elaboration, heuristics (Perkins 1981)
Definition	Perceives or acts effectively by anticipating the organization, involves both perception and production. (Perkins 1981)
Dispositions	Risk-taking, complexity, openness, direct remembering, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 9

Sample Activity	Given characteristics of revolutions, students determine current patterns and potential outcomes of conflicts in the Middle East and South Africa.
Evaluation Criteria	Accuracy in recognition of patterns in complex stimulus field

Grade 10

Sample Activity	Given a set of population data, students describe the interrelationship of species in the food chain, describe the populations in terms of size, density, reproductive rate, age, distribution and carrying capacities, and harvestable surplus.
Evaluation Criteria	Comprehensiveness of relational scheme

Grade 11

Sample Activity	In an ecology study of the effects of man and industry on the natural community, students determine threats to a local wildlife area and develop an action plan to alert them.
Evaluation Criteria	Ease in product implementation; completeness of plan

Sample Activity	Given principles of chemistry, physics, and mathematics, students determine the height of an unknown skeleton based on the measurements of 5 bones of the body.
Evaluation Criteria	Appropriateness of developed procedure; accuracy of knowledge application

Process Evaluation

Skills	Flexibility, elaboration, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)
Definition	Judges an idea to see whether it is going to work, looks at criteria, advantages and disadvantages. (De Bono 1970)
Dispositions	Complexity, openness, intuitiveness, (Perkins 1981) critical reasoning (Perkins 1981)

Grade 9

Sample Activity	It has been suggested that sterile needles be distributed to drug dependent individuals to slow the spread of AIDS. Is this a feasible contribution to the fight against an AIDS epidemic? Consider advantages/disadvantages.
Evaluation Criteria	•Comprehensiveness; congruence; applicability across solution levels •Balance, objectivity, validity of categorization

Grade 10

Sample Activity	After completing a unit on science fiction, students research projections of futurists and determine their validity and desirability.
Evaluation Criteria	Comprehensiveness; congruence; applicability across solution levels

Grade 11

Sample Activity	Scenario: Lawmakers are discussing a minimal age limitation of 21 for AFDC payments. Some believe this to be a possible detriment to teen pregnancy. Is this an effectual plan?
Evaluation Criteria	Balance, objectivity, validity of categorization

Grade 12

Sample Activity	Research the economic base of a Third World Nation. Using criteria incorporating geography, natural resources, and work force, determine an appropriate economic direction. Be aware of advantages/disadvantages of suggested economic actions.
Evaluation Criteria	•Comprehensiveness, congruence; applicability across solution levels •Balance, objectivity, validity of categorization

Process	Problem Finding
Skills	Flexibility, abstraction
Definition	Narrows a problem situation, proceeds to identification of an underlying problem. (Perkins 1981)
Dispositions	Complexity, openness, critical reasoning (Perkins 1981)
Grade 9	
Sample Activity	Students identify problems related to the increased use of nuclear power, then identify the underlying problem.
Evaluation Criteria	Accuracy in problem identification in potential, future situations
Grade 10	
Sample Activity	Students identify problems related to competition, expectations, and stress, and determine a potential underlying common problem.
Evaluation Criteria	Accuracy in problem identification in personal, in complex situations
Grade 11	
Sample Activity	Students identify the problems of current foreign policy in regard to China and the Soviet Union. Students search for common underlying problems.
Evaluation Criteria	Accuracy in problem identification of complex, global situations
Grade 12	
Sample Activity	Students identify problems of the current space program and determine the major underlying problem.
Evaluation Criteria	Accuracy in problem identification

Process Creative Problem Solving Model

Skills	Fluency, flexibility, originality, abstraction, schemata, (Perkins 1981) heuristics (Perkins 1981)
Definition	Uses fact finding, problem identification, idea production, solution finding in the development of an action plan. (Parnes 1970)
Dispositions	Risk-taking, complexity, curiosity, imagination, openness, tolerance for ambiguity, intuitiveness, (Perkins 1981) critical reasoning. (Perkins 1981)

Grade 9

Sample Activity	Using Creative Problem Solving, students identify ways to increase public awareness of the threat of acid rain.
Evaluation Criteria	•Number, variety, originality, practicality •Appropriate use of CPS on environmental/ecological problems or issues

Grade 10

Sample Activity	Students use the problem solving method and develop an action plan to reduce the trade deficit.
Evaluation Criteria	•Number, variety, correctness of knowledge application, practicality •Appropriate use of CPS on economic/business problems

Grade 11

Sample Activity	Students use the problem-solving process to develop an action plan to resolve conflicts in the Middle East.
Evaluation Criteria	•Number, variety, correctness of knowledge application, practicality •Appropriate use of CPS on political/global issues or problems

Grade 12

Sample Activity	Students use the problem solving process to identify alternative ways to solve the problem of Grindel in <i>Beowulf</i> .
Evaluation Criteria	•Number, variety, originality, correctness of knowledge application, practicality •Appropriate use of CPS on political/global issues as well as personal problems

Process Recognizing Premises/Structure of Argument

Skill	Identifying Inconsistencies of Logic (9-12)
Definition	To note areas of incongruity or inconsistency in the presentation of an argument. The student recognizes as invalid conclusions that are not reached in an orderly or systematic fashion (or insights that cannot later be verified by supporting evidence).
Dispositions	Displays intellectual curiosity, searching for relationships, using systematic approaches
Evaluation Criteria	Accuracy of identification of logical inconsistencies

Process Recognizing Premises/Structure of Argument

Skill	Judging if a Theory is Warranted (9-12)
Definition	To use objective criteria to determine if a hypothesis or an abstract principle is plausible or scientifically acceptable. The student determines the acceptability or likelihood of a given theory by establishing and applying appropriate evaluation criteria.
Dispositions	Being open-minded, flexibility of thought, searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	As a class, students will brainstorm the attributes of an acceptable theory regarding the beginning of the universe. Individual students will then evaluate existing theories based on the criteria generated.
Evaluation Criteria	•Appropriateness of established criteria •Accurate application of criteria

Process Recognizing Premises/Structure of Argument

Skill	Validity Testing (9-12)
Definition	To determine the strength or accuracy of an argument. The student analyzes the accuracy of data, the consistency of the statement, and the logic of the reasoning to determine the validity of an argument.

Dispositions	Being open-minded, flexibility of thought, searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	As part of a writing lab the student writes a letter of persuasion. The letter is critiqued by a class member who edits for concrete supporting evidence, elimination of inconsistent argument, and logical systematic reasoning.
Evaluation Criteria	•Accuracy in identifying argument strength •Clarity of evidence used to support original thesis
Process	Recognizing Viewpoint
Skill	Estimating Value Conflicts (9-12)
Definition	To assess the coherence of specific actions and ideals and determine the compatibility of personal desires and social sanctions. The student recognizes the components of controversy, including the potential conflict inherent in opposing viewpoints.
Dispositions	Being open-minded, flexibility of thought, respecting viewpoints of others, reflective behavior
Sample Activity	The student analyzes the debate over aid to the Contra rebels, determining which typically American social sanctions are satisfied by an aid program, and which are in conflict.
Evaluation Criteria	•Accuracy in recognition of opposing viewpoints •Accuracy and completeness of delineated controversy components

Process Recognizing Viewpoint

Skill	Recognizing Slanted Arguments (9-12)
Definition	To recognize the underlying structure of a particular proposition, statement, position, or viewpoint. The student recognizes causal claims, generalizations, analogies, and assumptions when they are used to support an argument.
Dispositions	Searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	During an election year, students analyze the "stump speeches" of major candidates and compile examples of causal claims, generalizations, etc.
Evaluation Criteria	Accuracy of recognition of strategies used to structure argument

Process Judging Relevancy/Completeness of Data

Skill	Organizing Data For Effective Use (9-12)
Definition	To establish and use criteria to systematize pieces of information. The student chooses standards that will create the clearest interpretation of the facts. The student selects criteria that will allow the data to be interpreted in a logical, orderly fashion.
Dispositions	Searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	In preparing a research paper, the student puts individual facts, ideas, quotes, or pieces of data on separate notecards. When preparing the outline for the paper, the student then sorts the cards into piles of related material. Each pile then tentatively represents the contents of a paragraph or section of the paper. These sections can then be organized into a logical, systematic presentation.
Evaluation Criteria	•Logic of criteria established •Appropriate application of criteria

Process	Judging Relevancy/Completeness of Data
Skill	Judging Completeness of Data (9-12)
Definition	To assess data to determine if they are sufficient for thorough coverage of the subject or issue under consideration. The student recognizes when data is sufficient or insufficient to meet a predetermined requirement.
Dispositions	Searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	As a class, students generate a list of things they would like to know about penguins. Individual students are assigned to seek out complete information on each topic (food, habitat, mating habits, etc.). Class members critique the reports by assessing how thoroughly the original question was answered, and what questions regarding that topic still remain.
Evaluation Criteria	•Thoroughness of data collected •Ability to reach closure of data collection when appropriate to task

Process	Judging Relevancy/Completeness of Data
Skill	Detecting Ambiguity (9-12)
Definition	To recognize the possibility of two or more possible interpretations of a communication because 1) of the manner in which the words are arranged, 2) a word may be interpreted in more than one way within the same text, and/or 3) data is missing. The student identifies ambiguous statements and is able to analyze the cause of the uncertainty.
Dispositions	Flexibility of thought, searching for relationships, using systematic approaches, reflective behavior, persistence
Sample Activity	Given the statement "Women need to be concerned with the values of men in the workplace," the student lists a number of possible interpretations for that statement. He or she then chooses three of those interpretations to write in a clear, unambiguous form.
Evaluation Criteria	Accuracy in judgment of ambiguous statements

ASSESSMENT AND EVALUATION OF STUDENT THINKING

Many procedures and measurements are available to educators to evaluate the content knowledge acquired by students. However, the techniques and conditions which are required to assess and evaluate student abilities in thinking skills, production and completion of complex tasks are disturbingly absent in educational practice.

Resnick and Klopfer (1989) identified two key questions regarding the infusion of a thinking curriculum into school programs. "How can adequate time be found in the crowded school program for the kinds of educational activities advocated here? And how can the mandated testing and assessment that is demanded almost anywhere today be made compatible with the kind of education proposed by our authors?"

In response to the problem of adequate time, a closer examination of the content is needed and a reduction in the teacher's efforts to "cover" all of the content offered in textbooks should result. (Resnick and Klopfer 1989) Regarding assessment of student thinking, performance assessments are advocated "... that evaluate students' ability to engage in the kind of integrated, complex reasoning and problem solving that is the hallmark of the thinking curriculum and will provide important public evidence of the kind of learning that can result." (Resnick and Klopfer 1989)

In the next section, areas of evaluation are suggested and an example of "performance-based" criteria for each area is described. In each case, descriptors of behaviors or actions (criteria) are written. If a student were thinking critically on this task, what would be observed? What would be a high level performance-what criteria might be used to determine basic competence? A "prompt" is designed to engage the student in an activity where the processes/skills may be observed.

This prompt might be a problem-solving task or a five-minute debate. The observer may record a "self-report" of the student's thinking while he or she is engaged in a challenging task. The student's performance is then evaluated over time and/or a group of students may be randomly evaluated at a grade level for a particular process/skill or behavior. A definition for each "thinking area" and an example follows.

**Dispositions and
metacognition**

Assessment of dispositions and metacognitive behaviors occurs when data is gathered regarding a general pattern of behavior or response as it relates to the completion of a complex task. For example, the student may be assessed for evidence of persistence, task completion, or openness to another point of view.

To observe persistence, the following general pattern of behavior may be evident:

- student continues to work on a task despite difficulty of task
- student tries alternative strategies
- student seeks additional resources to assist in task completion
- student paces herself or himself appropriately and is goal-directed toward completion of task
- student completes task

**Thinking processes
and skills**

Assessment of the use of thinking skills/strategies occurs when data is gathered regarding: the repertoire of processes/skills the individual displays; the intelligent selection of an appropriate process/skill for a particular task; the appropriate and efficient application of the process/skill to accomplish a particular task; and the monitoring process that the individual engages during the work stages and at the completion of the task.

For example, the student may be assessed for the use of a creative problem-solving model, the operations involved in drawing a conclusion, or the identification of flaws in an argument structure advanced in a newspaper editorial.

The student who is able to appropriately apply a creative problem-solving model is able to:

- identify several subproblems from a mess
- identify and state a manageable problem
- generate alternative solutions
- define criteria
- evaluate solutions
- develop an action plan

Complex Tasks

Assessment of appropriate actions toward the completion of complex tasks occurs when data is gathered regarding: the identification and sequencing of steps toward task completion; the monitoring of the action phases used toward completion of each step; devising/ knowing/applying criteria for the successful completion of each step; and competent performance as defined by criteria for the stages of investigation and final completion of the task.

Examples of complex tasks are: students conduct a scientific experiment; students plan an event such as **Grandparents' Day**; students work collaboratively during the phases of a simulation on world peace; or students use an electronic search procedure to discover related areas of information in an electronic encyclopedia.

For example, students may be assessed regarding their competency during the research phases of investigation where an electronic search procedure is used. The following criteria may be used to critique student performance:

- ability of the student to "open" the software and efficiently begin the search procedure
- sophistication of "descriptors" employed which define and narrow search topic (women and pioneers and 1900...)
- use of logical systems which limit and refine search task
- creativity employed in the use of "key word" descriptors to identify and develop a research topic
- thoroughness and efficiency of electronic search

Products

Products involve the application of complex, sophisticated, and/or novel strategies of experts in a given field. Products reveal a pattern of thinking and communicate original work in an appropriate format. Products may be used as a tool for learning or as a verification of learning.

Examples of product formats include: research papers, posters, inventions, scientific experiments, debates, and newspapers. Criteria for the evaluation of student products is developed for both the "content" of the productive work as well as the "format" of the work. For example, students who construct the front page of a newspaper during colonial times must accomplish this task by portraying historically accurate information and presenting this information in the correct format of the front page of a newspaper.

The following criteria may be used to evaluate the final product:

Content

- important historical information was included in the stories
- information was reported accurately
- research included primary and secondary sources

Format

- stories are written in a journalistic style; the five w's (who, what, where, when, and why) were included
- headlines capture the attention of the reader
- page layout is attractive and in keeping with historical style
- illustrations add important visual information and captions help to capture the essence of the story line

A vigorous effort to improve student's thinking capabilities means a commitment to measure and be accountable for qualitatively difficult-to-assess outcomes.

Summary

Basic content and skill knowledge in the fields of communications, mathematics, the sciences, and the arts is the foundation upon which the individual builds skills in an ever changing and complex world. The "basics" might be thought of as a bank account, where rich knowledge is available currency for understanding the past, operating in the present, and planning for the future. The portable skills of problem solving, higher order thinking, and the ability to be competent in a variety of challenging tasks are the students' savings account and ready reserve. These thinking tools may be drawn on for future investments and provide stability during uncertain market conditions. The development of students' thinking abilities must certainly be a requirement to meet the challenges of the 90's and beyond.

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